CLAIMS

What is claimed is:

1. A method for reducing spurious emissions in an amplified signal by applying pre-distortion, whose magnitude is frequency-dependent, to an input signal to generate a pre-distorted signal, such that, when the pre-distorted signal is applied to an amplifier to generate the amplified signal, the pre-distortion reduces spurious emissions in the amplified signal, wherein the pre-distorted signal is generated by:

(a) generating a first frequency-dependent pre-distortion signal corresponding to a first set of frequency components for the input signal;

(b) generating a second frequency-dependent pre-distortion signal corresponding to a second set of frequency components for the input signal, wherein the first set of frequency components is different from the second set of frequency components; and

(c) combining the first and second frequency-dependent pre-distortion signals to generate the pre-distorted signal.

2. The invention of claim 1, wherein the phase of the pre-distortion is also frequency-dependent.

3. (e.g., Fig. 5) The invention of claim 1, wherein:

the first set of frequency components corresponds to positive frequency components of the input signal; and

the second set of frequency components corresponds to negative frequency components of the input signal.

4. (e.g., Fig. 5) The invention of claim 3, wherein:

the first frequency-dependent pre-distortion signal is generated by:

(1) generating a first set of one or more waveforms corresponding to a first set of one or more pre-distortion parameters;

(2) differentiating the first set of one or more waveforms with respect to time to generate a first set of one or more differentiated waveforms; and

(3) applying the first set of one or more differentiated waveforms to a positive-frequency operation to generate the first frequency-dependent pre-distortion signal; and

the second frequency-dependent pre-distortion signal is generated by:

(1) generating a second set of one or more waveforms corresponding to a second set of one or more pre-distortion parameters;

(2) differentiating the second set of one or more waveforms with respect to time to generate a second set of one or more differentiated waveforms; and

(3) applying the second set of one or more differentiated waveforms to a negative-frequency operation to generate the second frequency-dependent pre-distortion signal.

5. (e.g., Figs. 8-9) The invention of claim 1, wherein:

the first set of frequency components corresponds to positive and negative frequency components of the input signal; and

the second set of frequency components corresponds to only positive frequency components or only negative frequency components of the input signal.

6. (e.g., Figs. 8-9) The invention of claim 5, wherein:

the first frequency-dependent pre-distortion signal is generated by:

(1) generating a first set of one or more waveforms corresponding to a first set of one or more pre-distortion parameters;

(2) differentiating the first set of one or more waveforms with respect to time to generate the first frequency-dependent pre-distortion signal; and

the second frequency-dependent pre-distortion signal is generated by:

(1) generating a second set of one or more waveforms corresponding to a second set of one or more pre-distortion parameters;

(2) differentiating the second set of one or more waveforms with respect to time to generate a second set of one or more differentiated waveforms; and

(3) applying the second set of one or more differentiated waveforms to a negative-frequency operation or a positive-frequency operation to generate the second frequency-dependent pre-distortion signal.

7. The invention of claim 1, further comprising the step of generating a frequency-independent pre-distorted signal from the input signal, wherein the frequency-independent pre-distorted signal and the first and second frequency-dependent pre-distortion signals are combined to generate the pre-distorted signal.

8. The invention of claim 1, wherein:

the input signal is represented in a base-band domain; and

the first and second frequency-dependent pre-distortion signals are generated in a digital domain.

9. An apparatus for applying pre-distortion to an input signal to generate a pre-distorted signal, such that, when the pre-distorted signal is applied to an amplifier to generate an amplified signal, the pre-distortion reduces spurious emissions in the amplified signal, the apparatus comprising:

(a) a first signal processing path adapted to generate a main pre-distortion signal from the input signal;

(b) a second signal processing path adapted to generate a first frequency-dependent pre-distortion signal corresponding to a first set of frequency components for the input signal;

(c) a third signal processing path adapted to generate a second frequency-dependent pre-distortion signal corresponding to a second set of frequency components for the input signal, wherein the first set of frequency components is different from the second set of frequency components; and

(d) a combiner adapted to combine the first and second frequency-dependent pre-distortion signals with the main pre-distortion signal to generate the pre-distorted signal.

10. (Fig. 5) The invention of claim 9, wherein:

the first set of frequency components corresponds to positive frequency components of the input signal; and

the second set of frequency components corresponds to negative frequency components of the input signal.

11. (Fig. 5) The invention of claim 10, wherein:

the first frequency-dependent pre-distortion signal is generated by:

(1) generating a first set of one or more waveforms corresponding to a first set of one or more pre-distortion parameters;

(2) differentiating the first set of one or more waveforms with respect to time to generate a first set of one or more differentiated waveforms; and

(3) applying the first set of one or more differentiated waveforms to a positive-frequency operation to generate the first frequency-dependent pre-distortion signal; and

the second frequency-dependent pre-distortion signal is generated by:

(1) generating a second set of one or more waveforms corresponding to a second set of one or more pre-distortion parameters;

(2) differentiating the second set of one or more waveforms with respect to time to generate a second set of one or more differentiated waveforms; and

(3) applying the second set of one or more differentiated waveforms to a negative-frequency operation to generate the second frequency-dependent pre-distortion signal.

12. The invention of claim 11, wherein the positive- and negative-frequency operations are implemented using filters.

13. (e.g., Figs. 8-9) The invention of claim 9, wherein:

the first set of frequency components corresponds to positive and negative frequency components of the input signal; and

the second set of frequency components corresponds to only positive frequency components or only negative frequency components of the input signal.

14. (e.g., Figs. 8-9) The invention of claim 13, wherein:

the first frequency-dependent pre-distortion signal is generated by:

(1) generating a first set of one or more waveforms corresponding to a first set of one or more pre-distortion parameters;

(2) differentiating the first set of one or more waveforms with respect to time to generate the first frequency-dependent pre-distortion signal; and

the second frequency-dependent pre-distortion signal is generated by:

(1) generating a second set of one or more waveforms corresponding to a second set of one or more pre-distortion parameters;

(2) differentiating the second set of one or more waveforms with respect to time to generate a second set of one or more differentiated waveforms; and

(3) applying the second set of one or more differentiated waveforms to a negative-frequency operation or a positive-frequency operation to generate the second frequency-dependent pre-distortion signal.

15. The invention of claim 14, wherein the positive-frequency operation or the negative-frequency operation is implemented using a filter.

16. The invention of claim 9, wherein:

the input signal is represented in a base-band domain; and

the main pre-distortion signal and the first and second frequency-dependent pre-distortion signals are generated in a digital domain.

17. The invention of claim 9, wherein:

the first signal processing path comprises:

(1) an index generator adapted to generate index values proportional to envelope power of the input signal;

(2) a first look-up table adapted to provide first and second pre-distortion parameters using the index values; and

(3) a first multiplier adapted to multiply the input signal by the first and second pre-distortion parameters to generate the main pre-distortion signal;

the second signal processing path comprises:

(1) a second look-up table adapted to provide third and fourth pre-distortion parameters using the index values;

(2) a second multiplier adapted to multiply the input signal by the third and fourth pre-distortion parameters to generate first multiplied signals; and

(3) a first differentiator adapted to differentiate the first multiplied signals with respect to time to generate first differentiated signals; and

the third signal processing path comprises:

(1) a third look-up table adapted to provide fifth and sixth pre-distortion parameters using the index values;

(2) a third multiplier adapted to multiply the input signal by the fifth and sixth pre-distortion parameters to generate second multiplied signals; and

(3) a second differentiator adapted to differentiate the second multiplied signals with respect to time to generate second differentiated signals.

18. (e.g., Fig. 5) The invention of claim 17, wherein:

the second signal processing path further comprises a positive-frequency filter adapted to filter the first differentiated signals to generate the first frequency-dependent predistortion signal; and

the third signal processing path further comprises a negative-frequency filter adapted to filter the second differentiated signals to generate the second frequency-dependent predistortion signal.

19. (e.g., Figs. 8-9) The invention of claim 17, wherein:

the first differentiated signals are the first frequency-dependent predistortion signal; and

the third signal processing path further comprises either a positive-frequency filter or a negative-frequency filter adapted to filter the second differentiated signals to generate the second frequency-dependent predistortion signal.